CLAIMS

WE CLAIM:

1. A method comprising:

loading a microstructure into an etch chamber of the etch system, wherein the microstructure comprises a sacrificial material and one or more structural materials;

providing a spontaneous vapor phase etchant recipe to the etch system; and

providing an additional amount of the etchant recipe to the etch system at a time that is determined based on a measurement of an amount of a chemical species.

2. The method of claim 1, wherein the chemical species is an etchant of the etchant recipe.

3. The method of claim 1, wherein the chemical species is an etch product.

4. The method of claim 1, wherein the chemical species is an etchant of the etchant recipe.

5. The method of claim 1, wherein the spontaneous vapor phase etchant recipe comprises a noble gas halide.

6. The method of claim 5, wherein the noble gas halide is xenon difluoride.

7. The method of claim 1, wherein the etchant recipe comprises a spontaneous interhalogen.

8. The method of claim 7, wherein the interhalogen comprises bromine trichloride or bromine fluoride.

9. The method of claim 1, wherein the etchant recipe comprises vapor phase HF.

10. The method of claim 1, wherein the etchant recipe comprises a diluent gas.

11. The method of claim 10, wherein the diluent gas is an inert gas that is selected from N_2, He, Ar, Kr and Xe.

12. The method of claim 1, wherein the step of providing the additional amount of the etchant is performed when a change of the measured amount of the chemical species over time is beyond a predetermined value.

13. The method of claim 1, wherein the step of providing the spontaneous vapor phase etchant further comprises:

preparing the etchant in an exchange chamber; and

feeding the prepared etchant via an outer circulation loop that passes through the exchange chamber and an etch chamber in which the microstructure is held.

14. The method of claim 13, further comprising: opening the outer circulation loop for feeding another additional amount of the etchant into the etch system.

15. The method of claim 1, further comprising: repeating the steps of claim 100 until the measurement of the amount of the chemical species is equal to or below another predefined value.

16. The method of claim 1, further comprising: coating the microstructure with a SAM material.

17. The method of claim 1, wherein the etchant has a pressure from 0 to 15 torr.

18. The method of claim 10, wherein the diluent gas has a partial pressure from 20 to 700 torr.

19. The method of claim 18, wherein the diluent gas has a partial pressure from 50 to 100 torr.

20. The method of claim 10, wherein the diluent gas has a partial pressure from 500 to 700 torr.

21. The method of claim 10, wherein the diluent gas has a partial pressure around 100 torr.

22. The method of claim 17, wherein the etchant has a temperature around 25° degrees.

23. The method of claim 18, wherein the diluent gas has a temperature around 25° degrees.

24. The method of claim 15, wherein the predefined value is 1%.

25. The method of claim 12, wherein the predefined value is 20%.

26. The method of claim 1, wherein the structural materials remain in the microstructure after the removal of the sacrificial materials, wherein the structural material is selected from a group that comprises: an elemental metal, a metalloid, an intermetallic compound and a ceramic material.

27. The method of claim 26, wherein the elemental metal is selected from Al, Cu and Pt..

28. The method of claim 26, wherein the intermetallic compound is selected from Ti_xAl_x and TiNi.

29. The method of claim 26, wherein the ceramic material comprises a transition metal nitride, transition metal oxide, transition metal carbide, transition metal oxynitride, transition metal silicon nitride, transition metal silicon oxynitride, metalloid nitride, metalloid oxide, metalloid carbide, metalloid oxynitride.

30. A method comprising: loading a microstructure into an etch chamber of an etching system; and providing an etchant recipe to the etch chamber over time, wherein an amount of the etchant recipe per time unit varies.

31. The method of claim 30, wherein the etchant recipe is a spontaneous vapor phase etchant recipe.

32. The method of claim 31, further comprising:
providing a first amount of the etchant recipe at a first time; and
providing a second amount of the etchant recipe at a second time.

33. The method of claim 32, wherein the first amount equals the second amount.

34. The method of claim 32, wherein the first amount does not equal the second amount.

35. The method of claim 32, further comprising:
providing a third amount of the etchant recipe at a third time, wherein the interval between the first time and the second time does not equal the interval between the second time and the third time.

36. The method of claim 32, further comprising:
providing a third amount of the etchant recipe at a third time, wherein the interval between the first time and the second time equals the interval between the second time and the third time.

37. The method of claim 32, further comprising:
measuring a parameter of the etching process; and
wherein the step of providing the second amount of the etchant recipe is executed based on the measured parameter.

38. The method of claim 37, wherein the parameter is selected from a concentration of an etchant of the etchant recipe, a concentration of an etch product, an etch rate and a surface area of a sacrificial material within the etch chamber.

39. The method of claim 32, further comprising:

measuring a parameter of the etching process; and

wherein the step of providing the second amount of the etchant recipe is executed when a change of the measured parameter reaches a predetermined value.

40. The method of claim 31, wherein the spontaneous vapor phase etchant recipe comprises an interhalogen.

41. The method of claim 39, wherein the interhalogen comprises bromine trichloride or bromine trifluoride.

42. The method of claim 31, wherein the spontaneous vapor phase etchant recipe comprises a noble gas halide.

43. The method of claim 42, wherein the noble gas halide comprises xenon difluoride.

44. The method of claim 31, wherein the etchant recipe comprises a non-etchant diluent gas.

45. The method of claim 44, wherein the non-etchant diluent gas comprises an inert gas that is selected from N_2, He, Ar, Kr, Neon and Xe.

46. The method of claim 45, wherein the diluent gas has a partial pressure from 20 to 700 torr.

47. The method of claim 45, wherein the diluent gas has a partial pressure is from 500 to 700 torr.

48. The method of claim 30, wherein the structural materials remain in the microstructure after the removal of the sacrificial materials.

49. The method of claim 30, wherein the structural materials remain in the microstructure after the removal of the sacrificial materials, wherein the structural material is selected from a group that comprises: an elemental metal, a metalloid, an intermetallic compound and a ceramic material.

50. The method of claim 49, wherein the elemental metal is selected from Al, Cu and Pt..

51. The method of claim 49, wherein the intermetallic compound is selected from Ti_xAl_x and TiNi.

52. The method of claim 49, wherein the ceramic material comprises a transition metal nitride, transition metal oxide, transition metal carbide, transition metal oxynitride, transition metal silicon nitride, transition metal silicon oxynitride, metalloid nitride, metalloid oxide, metalloid carbide, metalloid oxynitride.

53. A method for etching a microstructure in an etch chamber, the method comprising:

providing an etchant recipe to the etch chamber over time, wherein an amount of the etchant is varied when a change of a measured parameter beyond a predetermined value.

54. The method of claim 53, wherein the measured parameters is selected from a concentration of an etch product, the concentration of the etchant, an etch rate and a surface area of a sacrificial material.

55. The method of claim 53, wherein the etchant recipe is a spontaneous vapor phase etchant.

56. The method of claim 55, wherein the etchant recipe comprises a spontaneous vapor phase interhalogen.

57. The method of claim 55, wherein the interhalogen comprises bromine trifluoride.

58. The method of claim 55, wherein the etchant recipe comprises a noble gas halide.

59. The method of claim 58, wherein the noble gas halide comprises xenon difluoride.

60. The method of claim 55, wherein the etchant recipe comprises HF.

61. The method of claim 55, wherein the etchant recipe comprises a non-etchant diluent gas.

62. The method of claim 60, wherein the non-etchant diluent gas comprises an inert gas that is selected from N_2, He, Ar, Kr neon and Xe.

63. A method of etching a plurality of microstructures in an etch chamber, the method comprising: collecting data of a parameter during a first etching process for a first microstructure using an etchant recipe; determining a variation profile of the parameter in the first etch process; and etching a second microstructure in a second etching process using the etchant recipe based on the collected data of the parameter in the first etching process.

64. The method of claim 63, wherein the measured parameter is selected from a concentration of an etch product, the concentration of the etchant, an etch rate and a surface area of a sacrificial material.

65. The method of claim 63, wherein the etchant recipe comprises a spontaneous vapor phase etchant.

66. The method of claim 65, wherein the etchant recipe comprises an interhalogen.

67. The method of claim 66, wherein the interhalogen comprises bromine trifluoride.

68. The method of claim 65, wherein the etchant recipe comprises a noble gas halide.

69. The method of claim 68, wherein the noble gas halide comprises xenon difluoride.

70. The method of claim 65, wherein the etchant recipe comprises a non-etchant diluent gas.

71. The method of claim 70, wherein the non-etchant diluent gas comprises an inert gas that is selected from N_2, He, Ar, Kr Ne and Xe.

72. A method of etching a plurality of microstructures in a plurality of etching processes, the method comprising: collecting a plurality of data of a parameter that characterizes an etching process using an etchant recipe; storing the collected data; and etching a microstructure using the etchant recipe based on the collected data of the parameter.

73. The method of claim 72, wherein the measured parameter is selected from a concentration of an etch product, the concentration of the etchant, an etch rate and a surface area of a sacrificial material.

74. The method of claim 72, wherein the etchant recipe is a spontaneous vapor phase etchant recipe.

75. The method of claim 74, wherein the etchant recipe comprises an interhalogen.

76. The method of claim 75, wherein the interhalogen comprises bromine trifluoride.

77. The method of claim 74, wherein the etchant recipe comprises a noble gas halide.

78. The method of claim 77, wherein the noble gas halide comprises xenon difluoride.

79. The method of claim 74, wherein the etchant recipe comprises a non-etchant diluent gas.

80. The method of claim 79, wherein the non-etchant diluent gas comprises an inert gas that is selected from N_2, He, Ar, Kr, neon and Xe.